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Published by
TELEPHONY PUBLISHING CORP.
608 So. Dearborn Street, CHICAGO
Telephone Wabash 8604

H. D. FARGO, President and Treasurer
S. R. EDWARDS, Editor and Secretary
H. D. FARGO, JR., Vice-President and Advertising Manager
D. C. SORENSEN, Western Advertising Manager

Subscription — 10 Cents a Copy
$3 a Year U. S., Cuba and Mexico
$4 Canada, $5 Other Countries

Vol. 116 JUNE 10, 1939 No. 23

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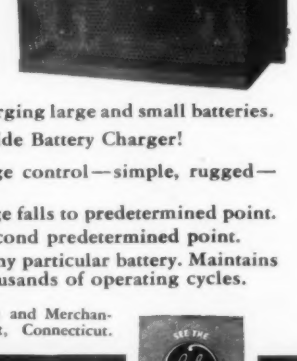

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GENERAL ELECTRIC

INDUCTIVE COORDINATION OF

Rural Power Lines and Rural Telephone Lines

By J. O'R. COLEMAN
Edison Electric Institute

R. H. HUNTLEY
American Telephone & Telegraph Co.

***PROBLEM OF** inductive coordination of rural power lines and telephone lines is one of locating, designing, operating and maintaining the two types of systems so as to result in the best service of both at the least overall cost to the public. Discussion of some of the factors involved*

IN VIEW of the wide-spread interest at the present time in the inductive coordination of long, lightly-loaded open-wire power distribution systems and telephone systems of the type frequently used for supplying service in rural areas, a brief review of some of the facts which have been developed through the joint work of the Edison Electric Institute and the Bell Telephone System, may be of value.

Considerable data on this subject have been published in one form or another and this article simply summarizes some of them and discusses their significance in a non-mathematical manner. References to published material will be found in the bibliography at the end of this article.

Perhaps the best way to introduce the subject is to reiterate a few fundamentals which, while they have been stated many times and on many occasions, seem particularly pertinent to the present subject.

(1) It is theoretically possible to build power systems which will have negligible inductive effects on neighboring telephone systems of any type.

(2) It is theoretically possible to build telephone systems which will be unaffected by neighboring power systems of any type.

(3) Even though it might be possible to reach the theoretical conditions of (1) or (2), this is, of course, ordinarily impracticable. Within the limits of practical considerations, the total cost of the telephone and power services to the public will be less when the inductive influence (ability to affect neighboring telephone lines) of the power system is kept as low as practicable and the susceptiveness (ability to be affected by neighboring power systems) of the telephone system is kept as low as practicable, and the two systems are "coordinated."

The problem of inductive coordination is, therefore, the intensely practical one of so locating, designing, operating and maintaining the two types of systems as to result in the best service of both types at the least overall cost to the public.

Perhaps the first thing which occurs to one in connection with coordination is the location of power and telephone lines. When considering long distance telephone lines and major power transmission lines, it is frequently practicable to plan substantial separations so as to limit inductive problems—although this is becoming increasingly difficult and expensive in many situations. Consequently, more and more reliance is necessarily being placed on other coordinative measures.

When it comes to power and telephone distribution systems, it is, in many cases, impracticable to avoid having the lines on the same highways because the customers of both services usually are the same. In such situations, coordination of the location of lines is still important but is directed toward securing conditions which will facilitate inductive coordination (such as keeping the separation uniform, avoiding frequent crossovers, etc.) rather than toward mere avoidance of exposures.

Uniformity of separation and avoidance of crossovers or other discontinuities are of great value because they permit telephone transpositions to be highly effective in reducing noise due to induction directly into metallic telephone circuits. Where additional inductive coordination measures are required, they are usually directed toward the control of power system influence and telephone circuit susceptiveness. The remainder of this article will be devoted to a brief discussion of these latter two subjects.

Power System Influence

The discussion under the heading of power system influence is entirely confined to rural power systems operating in the range of 11 to 13-kv. and having single-phase extensions consisting of phase wire and neutral or two phase wires. Some of the factors discussed are considerably different for other classes of circuits. Also, the discussion applies particularly to the influence of these circuits at roadway separation on either ground return or metallic open-wire rural telephone circuits.

The differences in influence between delta, uni-grounded neutral four-wire and multi-grounded neutral four-wire circuits and their single-phase extensions have been the subject of many recent discussions. Table No. 1 shows that for the 11 to 13-kv. class of three-phase rural circuits and the 6.9 to 7.6-kv. class of single-phase circuits, there is not much difference between uni- and multi-grounded neutral circuits, and that what difference there is, tends to be in favor of the multi-grounded neutral circuit.

These data, taken from a report of the joint subcommittee on development and research of the Edison Electric Institute and the Bell System[1], throw much light on this subject in that they show what hap-

Type of Circuit	Number of Comparisons	Number of Cases Where Ground Return I.T Product* Went Up When Circuit Was Converted from Uni-Grounded to Multi-Grounded Neutral	Number of Cases Where Ground Return I.T Product* Went Down When Circuit Was Converted from Uni-Grounded to Multi-Grounded Neutral
Three-phase 11 to 13-kv. circuits fed from delta-Y transformer banks	7	3	4
Three-phase 11 to 13-kv. circuits fed from direct-connected generators	9	3	6
Single-phase 7.6-kv. circuits metallically connected to three-phase, four-wire circuits	4	0	4
Single-phase 6.9 to 7.6-kv. circuits fed through single-phase transformers	8	3	5
Total	28	9	19

* I.T product means the magnitude of a current (as measured with an ammeter) times its T.I.F. (the significance of which is discussed later). It has been found that, for rural distribution circuits of the class discussed here, the ground return I.T product usually controls the inductive influence, except for exposures near the outer ends of circuits. Similar data are given in the report and in an A.I.E.E. paper[2] based on this report, with regard to voltage induction but they are not reproduced here. The comparison for voltages shows no great difference for the two classes of circuits.

Table No. 1. The comparisons illustrate the reactions in a number of cases when uni-grounded neutral 11-13-kv. circuits and single-phase extensions thereof were converted to multi-grounded neutral circuits.

pened in a number of cases when uni-grounded neutral 11-13-kv. circuits and single-phase extensions thereof were converted to multi-grounded neutral circuits. Since all factors except the neutral grounding conditions remain unchanged, this comparison is the most valid practicable.

A summary of the test results showing how delta circuits compare with other types is given in Table No. 2. These data show that in the 11-13-kv. class, the three-phase delta circuits tested had no advantage in general from the induction standpoint over uni- or multi-grounded neutral circuits.

The single-phase extension from a delta 7.2-kv. circuit tested had almost as high a ratio of ground return I.T to phase I.T as the average of the extensions from 11-13-kv. multi-grounded neutral circuits and half as high a ratio as the average of the extensions from 11-13-kv. uni-grounded neutral circuits. (Incidentally, this table also shows the same general indication as to the relation between multi- and uni-grounded neutral circuits as the previous table; also, it shows that the range of values in any one class of three-phase circuit is much larger than the average range between different classes.)

It was not practicable in the tests to get comparisons on the same circuit operated delta and then with uni- and multi-grounded neutral; but by using the ratio of ground return I.T to phase I.T, the limitations involved in making comparisons between different circuits are minimized.

(From a practical standpoint, there is no reason why the phase I.T should be different for delta than for grounded neutral circuits if both circuits are the same otherwise—that is, have the same voltage, layout, wave shape, etc.—so that this ratio is a reasonable measure of the relative ground return I.T for delta and grounded neutral operation.)

The remaining class of circuit is the single-phase isolated (non-grounded) circuit. As long as the wires of such a circuit are kept free from grounds, accidental or otherwise, its influence is relatively low. However, since this circuit has certain serious disadvantages from safety as well as power operating standpoints, it has not been widely used.

Now we come to the factors which, from a practical coordination standpoint, are of the greatest importance in connection with power circuit influence. They are:

(1) Wave shape (i.e., the magnitudes and frequencies of the harmonics).

(2) Balance of the three-phase portions of the power circuit.

In order to appreciate the importance of these factors it is necessary to deal with them in terms of the *harmonics* in the power system voltages and currents; that is, the voltages and currents having frequencies which are multiples of the fundamental. Let us first see why,

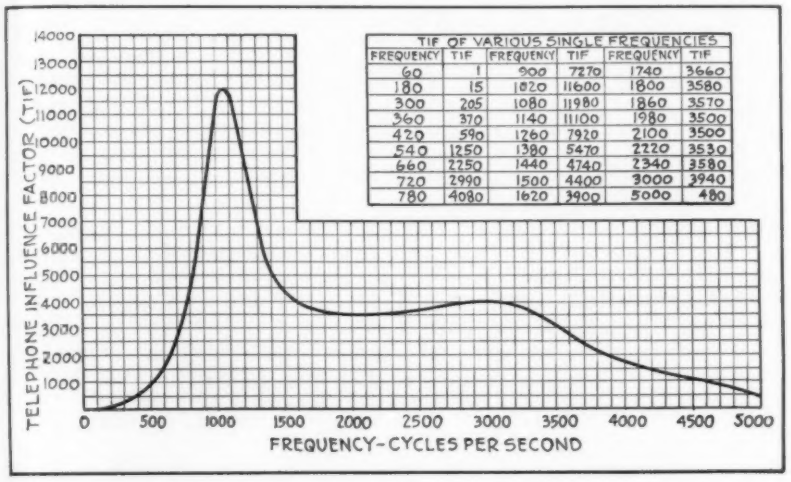
Type of Circuit	Number of Cases Tested	Ratio of Ground Return I.T to Phase I.T		
		Average	Minimum	Maximum
Three-phase, three-wire 11-kv. delta	4	.55	.16	.80
Three-phase, four-wire 11-13-kv. multi-grounded neutral fed from delta Y transformers	12	.36	.10	.81
Three-phase, four-wire 11-13-kv. uni-grounded neutral fed from delta Y transformers	7	.42	.16	.92
Single-phase extension, metallically connected to 7.2kv. delta circuit	1	.41	....	....
Single-phase extension from 11-13-kv. multi-grounded neutral system	4	.62	.58	.64
Single-phase extension from 11-13-kv. uni-grounded neutral system	4	.82	.78	.86

Table No. 2. Summary of tests which shows how three-phase delta circuits compare with other types of circuits.

[2] For all numbered references, see Bibliography at end of article.

in any power circuit, it is the harmonics which are important from the noise frequency induction standpoint.

Through years of study and experiments the relative interfering effects of currents and voltages of different frequencies have been derived. Fig. 1 shows these relative effects for a number of the commonly-encountered frequencies (the reasons why the different frequencies have different effects and the methods used in evaluating these effects, are amply covered in existing literature[3, 4, 5] and need not be discussed here).



TIF OF VARIOUS SINGLE FREQUENCIES

FREQUENCY	TIF	FREQUENCY	TIF	FREQUENCY	TIF
60	1	900	7270	1740	3660
180	15	1020	11600	1800	3580
300	205	1080	11980	1860	3570
360	370	1140	11100	1980	3500
420	590	1260	7920	2100	3500
540	1250	1380	5470	2220	3530
660	2250	1440	4740	2340	3580
720	2990	1500	4400	3000	3940
780	4080	1620	3900	5000	480

Fig. 1. Frequency weighting characteristics for TIF measurements.

It will be noted that the range of influence effects of different frequencies is very large—to take the extreme, the influence of one ampere of 1020-cycle current is nearly 12,000 times as much as one ampere of 60-cycle current—so that, even though the harmonic currents and voltages on a power system are usually relatively small in comparison to the fundamental, their effect on influence is controlling. The order of magnitude of this control can be visualized by a simple illustration:

As a general measure of the influence of a voltage or a current, the product of "TIF" (Telephone Influence Factor) times the voltage or current is frequently used and is referred to as the Kv.T or I.T product. This factor is the square root of the sum of the squares of the products of the magnitude of each harmonic present in the *particular voltage or current* under consideration and the appropriate weighting factor taken from the curve of Fig. 1.

To obtain the TIF alone, this value is divided by the r.m.s. voltage or current as measured by an ordinary voltmeter or ammeter. A TIF of 20 for a voltage or current is not at all unusual; but it means that the influence of that voltage or current is *20 times as great* as the influence of a pure 60-cycle voltage or current of the same magnitude would be. Instruments containing weighting networks are available for measuring these quantities directly.

For rural power circuits of the 11 to 13-kv. class, it is particularly important in considering inductive influence to think in terms of harmonics; not only because the harmonics are controlling in the influence but because the harmonics may arise at different places than the fundamental, follow different paths and be controlled by different factors.

Perhaps one of the most striking illustrations of this is in connection with a uni-grounded neutral or delta circuit. On a uni-grounded neutral or delta circuit, there is, of course, practically no 60-cycle current in the earth, but a relatively large proportion of the harmonic current may be in the earth—and it is the earth return harmonic current (ground return I.T product) which is usually the controlling factor in inductive influence, as pointed out previously.

In fact, the amount of harmonic earth return current may be—and frequently is—greater for delta or uni-grounded neutral circuits than for multi-grounded neutral circuits even though the 60-cycle earth return current is much smaller. (For those who would like to inquire further into the technical reasons for this, the brief discussion given in the appendix may be of interest—others may desire to skip it.)

Now, thinking in terms of harmonics, it is evident that one of the important factors in the influence of a rural power circuit (regardless of whether the neutral is uni-grounded, multi-grounded or not grounded at all) is the wave shape of the voltages impressed on the circuit (i.e., the *frequencies* and *magnitudes* of the harmonics in them), since the harmonic voltages acting on the capacitances and impedances involved determine the ground return I.T, as well as the influence of the voltages themselves.

The other important factor just mentioned, is the *balance* of the three-phase system. Thinking still in terms of harmonics, it is usually more important on 11 to 13-kv. lines to secure the best practicable balance among the capacitances to earth of the three phase wires than to secure good balance among the loads on the three phases. The balance of these capacitances is controlled very largely by the single-phase extensions connected to the three phases.

If the number and lengths of the extensions are nearly equal for the three phases, and are distributed reasonably uniformly along the three phase wires, the ground return I.T in, and hence the influence of, the three-phase circuit will be much lower (for given wave shape conditions) than if there is a large difference in the lengths and locations of the extensions.

The effects of the two factors just mentioned—wave shape and circuit layout — are much more important and show much greater variations between different circuits than the effects of the neutral grounding arrangements. It is not outside of the range of possibility that variations in influence of as much as 100 to 1 may occur between different circuits due to variations in these factors (which it will be observed later, is the same general order of magnitude as the difference in susceptiveness between metallic and ground return telephone circuits).

So far, little has been said about the effects of loads and load transformers. This is because they are not as important on 11 to 13-kv. rural lines as the other factors discussed —with one exception. Occasionally, some unusual load (such as a large motor with bad wave shape) may generate considerable harmonics which may give rise to an inductive coordination problem similar to that which may be caused by harmonics in the impressed voltage.

As to the effects of load transformers—on 11 to 13-kv. circuits,

with present standard transformer designs and with good voltage regulation, the magnitude of one of the higher harmonics in the impressed voltage is usually much more important than all of the transformers on the circuit put together.

One other point may be worth mentioning: It was pointed out previously that the influence of rural power lines is controlled by the ground return harmonic currents or occasionally by the harmonic residual voltages. Power circuit transpositions have no effect on the induction from ground return or residual components so that they are usually not worth while in rural power distribution circuits.

Telephone Circuit Susceptiveness

There are two general types of rural telephone circuits which have been used quite extensively — the "ground return" and the "metallic." The difference in susceptiveness between these two classes is quite large —the ratios found by the joint subcommittee on development and research being in the order of 100 to 1.

Why there is inherently a large difference can be readily shown. The voltage *directly* induced into a metallic telephone circuit is only the difference between the voltages induced into the two wires of the circuit due to the fact that they are at different distances from the power line. For a ground return circuit, however, the induction into the wire is impressed directly in the talking circuit. An example may clarify this:

Consider one wire of a telephone circuit at a separation of 50 feet from a power line. The induced voltage per 1000 feet of exposure per ampere of earth return, 1140-cycle current on the power line, is about .87 volt[e]. For a wire 51 feet from the power line (the other side of the metallic open-wire pair) the induced voltage per 1000 feet of exposure per ampere of earth return 1140-cycle current is about .863 volt.

For a ground return circuit the induced voltage in the talking path at this frequency would be .87 volt (or .863 volt, depending on which wire is used), whereas for the metallic circuit made up of those two wires the induced voltage in the talking circuit would be only the difference between .87 and .863, or .007 volt.

In this example the ratio between the induced voltages for the two classes of circuits is about 120 to 1. The voltage in the metallic circuit is frequently referred to as the "direct metallic circuit induction."

In practice the voltage at harmonic frequencies in the metallic circuit may be considerably lower or higher than this inherent difference indicates. If the circuit is suitably transposed, the direct metallic circuit induction may be greatly reduced. To illustrate this let us use the example just discussed:

Suppose that, in the middle of the 1000-foot exposure considered in this example, the positions of the two telephone wires were interchanged; then the first wire would have a voltage along it of $\frac{.870}{2} + \frac{.863}{2}$ or .867 volt. The second wire would have a voltage along it of $\frac{.863}{2} + \frac{.870}{2}$ or, again, .867 volt.

There would, therefore, be no voltage tending to cause noise in the metallic circuit. Of course, in practice this degree of perfection cannot be secured; but the direct metallic circuit induction can frequently be reduced by a large amount by the use of suitable transpositions, particularly if the relative locations of the lines have been coordinated.

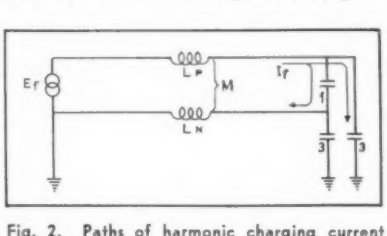


Fig. 2. Paths of harmonic charging current on short, uni-grounded single-phase line.

In an actual telephone line the transpositions are, of course, usually laid out and installed in accordance with regular patterns which minimize crosstalk between different telephone circuits as well as induction from power circuits.

The actual voltage acting in the metallic circuit may be higher than the inherent difference would indicate if the circuit is not well balanced. Unbalances may be of any of a large number of types, but the more common fall into the following classes:

1. Series resistance differences between the two wires of the circuit, usually due to resistance in the joints in the line wires.

2. Leakage differences between the two wires of the circuit, usually due to foliage growing into the line, missing insulators, wires against poles, dirt in protectors, etc.

3. Differences in the impedances to ground of the two wires at telephone stations, usually due to unbalanced connections of ringers of the lower impedance type to ground at the stations.

4. Differences in the impedances between the line wires to a ground connection in the line circuits or cord circuits in central offices.

The reason that unbalances can cause noise in the metallic talking circuit can be explained rather simply. Assume that we have a metallic telephone circuit in a relatively severe inductive exposure so that a substantial voltage exists on or along the wires of the circuit. Assume further that the exposure is perfectly uniform and the telephone circuit is perfectly transposed so that the direct metallic circuit induction is unimportant.

All telephone circuits have sufficient admittance to ground so that some harmonic current due to induction can flow in the wires. Now suppose that at some point in the circuit there exists a joint in one of the line wires having appreciable resistance.

The harmonic current in that wire flowing through this resistance will cause a harmonic voltage drop which is not matched by a similar voltage drop in the other wire and which, consequently, can drive current around the metallic circuit. This current, flowing through the receivers at the ends of the circuit, may be heard as noise.

Likewise, if there is more leakage on one wire of the circuit than the other, or if there is a difference in the impedances of the two wires to ground from any cause, the harmonic voltages between the wires and ground will drive more current through the wire with the lower impedance to ground and the greater voltage drop in this wire will tend to drive current around the metallic circuit.

It can readily be seen that a metallic circuit can be quiet in the presence of a strong inducing field only if it is adequately transposed and well balanced. Perfection, of course, cannot be secured and, consequently, while the metallic circuit is much less susceptive than the ground return circuit it is by no means immune to induction.

Conversely, it may be said that while the ground return circuit is much more susceptive than the metallic circuit, it can be operated under certain limited exposure conditions. It is fair to state, however, that the advantages from the induction standpoint of the metallic circuit are very great; not only because of the inherent improvement in susceptiveness but also because it lends itself more readily to the ap-

plication of coordinative measures.

This article makes no attempt to discuss the wide range of coordinative measures available for application to the power and telephone systems; much less does it attempt to tell what measures would be best for any particular situation. An array of such measures is available and new ones are constantly being developed.

There is, however, no panacea; and long experience has demonstrated that the only way to secure adequate and economical coordination is for the telephone and power engineers to work together to obtain the best engineering solution of each problem as it arises. If they pay attention to the power system wave shape and balance and the telephone system balance and transpositions, the way is not too hard.

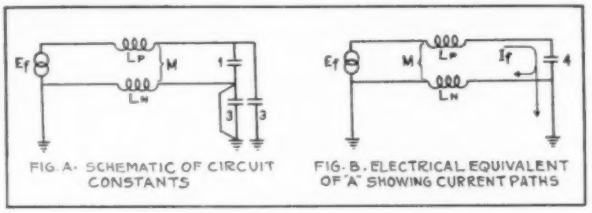


Fig. 3. Paths of harmonic charging current on short, multi-grounded single-phase line.

Appendix

This appendix discusses very briefly some of the underlying factors affecting the ground return harmonic currents on 11-13-kv. rural power circuits and single phase extensions thereof.

The starting point in this analysis is the capacitance to earth of the wires of the circuit. (For 60 cycles these capacitances can usually be neglected.) Consider Fig. 2, which, for simplicity, shows the capacitances involved in a short single-phase extension from a uni-grounded neutral circuit.

The numbers opposite the capacitances denote their approximate *relative* magnitudes. (Neglect the inductances L_p, L_n and M for the time being.) It can be seen that for a harmonic voltage E_f impressed at the source, a harmonic current I_f will flow in the phase wire and that about three-quarters of this current will go to ground and become ground return.

Fig. 3-A shows the same circuit as Fig. 2, but now it is multi-grounded. All that multi-grounding does in this case is to short-circuit the capacitance between the neutral and earth, thus permitting the division of current between the neutral and earth to be controlled by the *self and mutual impedances* (L_p, L_n and M) rather than by the relative capacitances (see Fig. 3-B).

The self and mutual impedances are such in the usual case that about 50 to 60 per cent of the charging current is earth return rather than the 75 per cent which occurred in the uni-grounded neutral case. (This partially explains why the influence may go down when a uni-grounded neutral system is converted to a multi-grounded neutral system.)

This is a very much simplified explanation of what actually happens on a rural circuit but it does bring out one of the very important principles. The actual case is usually much more complex since it involved three-phase as well as single-phase circuits; loads may have some effect, but, perhaps most important of all, propagation and resonance effects may occur. The complete story of these effects is too long to be included here and anyone interested should go to the more extensive literature on the subject[1, 2].

It may be pointed out, however, that for the longer rural circuits, the correct representation requires a number of elements like those in Figs. 2 and 3 in series and that for such a condition the inductances and capacitances may become resonant at some particular frequency, with a relatively large increase in the magnitude of the voltage or current or both at that frequency. Also, the capacitances of the line and the inductance of the supply transformers may become resonant at some particular frequency with similar effects.

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(1) Engineering Report No. 40 of the joint subcommittee on development and research of the Edison Electric Institute and Bell System, entitled "Inductive Coordination of Rural Power and Telephone Systems." This is a complete report of the experimental and theoretical work done by the joint subcommittee on noise frequency inductive coordination in rural areas.

(2) A.I.E.E. paper entitled "Noise Coordination of Rural Power and Telephone Systems" by H. W. Wahlquist, Edison Electric Institute and T. A. Taylor, Bell Telephone Laboratories, Inc. This paper was presented at the 1938 summer convention of the A.I.E.E. and was published in the November, 1938, issue of "Electrical Engineering." It contains a comprehensive discussion of the subject but does not have as much detailed data as Engineering Report No. 40.

(3) Engineering Report No. 32 of the joint subcommittee on development and research entitled "Relative Interfering Effects of Different Single-Frequency Noises in Telephone Circuits."

(4) Engineering Report No. 33 of the joint subcommittee on development and research entitled "The Telephone Influence Factor of Supply System Voltages and Currents."

(5) A.I.E.E. paper entitled "Measurement of Telephone Noise and Power Wave Shape" by J. M. Barstow and P. W. Blye, Bell Telephone Laboratories, Inc., and H. E. Kent, Edison Electric Institute; published in Electrical Engineering, December, 1935.

(6) Engineering Report No. 16 of the joint subcommittee on development and research entitled "A Method of Estimating Noise in Open-Wire Toll Circuits." This report contains curves of "Coefficients of Induction."

Northwestern Bell Aids in Railroad Celebration

The Northwestern Bell Telephone Co. had an active part in the celebration of "Golden Spike" days at Omaha, Neb., in commemoration of the 70th anniversary of the completion of the Union Pacific railroad, which has headquarters in that city.

The Northwestern Bell company had an exhibit in the historical show, built around the original golden spike brought to the city for the occasion. The telephone company had a better right to exhibit than most of the other participants since it was just 60 years ago that L. H. Korty, a telegrapher with the Union Pacific, brought the first telephones to Omaha and launched the company which later became a part of the Northwestern Bell System.

In the same year, 1879, similar starts in the telephone business were made in Minneapolis, Minn., Des Moines, Ia., and other cities which are now key points in the company's system. From a few dozen telephones the number of subscribers in Omaha has increased to 67,000 and in the Northwestern Bell System to 825,000. Theodore N. Vail, whose business astuteness built the foundations for the present Bell System, was in the early days a government mail clerk on the Union Pacific, running across Nebraska.

Company officials and employes also joined with Omaha people in giving a vivid setting to the celebration. The men wore beards and dozens of the operators donned typical old-time dresses for several weeks before the big day arrived.

In the Nation's Capital

by Francis X. Welch

Special Washington, D. C., Correspondent for TELEPHONY

REASONS ANALYZED which indicate the FCC report on the special telephone investigation will soon be made to Congress . . . Hopes for amendment of Wage-Hour Act shift to Senate . . . The financial condition of the government should command the attention of every business man, big or small

OVER AT THE FCC the folks are somewhat perturbed over recent newspaper gossip about the commission's difficulty over drafting a final report on the special telephone investigation. According to these newspaper stories (the most detailed of which appeared in The Wall Street Journal), the commission was hopelessly split over the report, with two members even hesitating about signing anything at all because of the doubtful quality of the evidence assembled by the special investigation staff.

The published story further suggested the likelihood that the FCC would be unable to compose its differences in time to submit a final report to the present session of Congress.

The other side of the story comes from parties within the FCC who were active in conducting the investigation. While they would say nothing definite or official, they pooh-pooh the idea there has been any collapse in the commission's drafting of the final report.

According to this source, the final drafting is coming along just dandy and there is an excellent possibility of the commission sending up to Congress a unanimous report, aside from minor reservations or observations by commissioners who were not parties to the investigation, or were not even members of the commission during the progress of the investigation hearings. (This would be true in the case of Chairman McNinch, Commissioners Craven and Thompson.)

The real situation doubtless lies somewhere in the middle. Certainly there could not have been so much newspaper smoke without a little bit of flame at least. And it is no secret that members of the commission have been pretty wide apart at times in considering various points of the final report to date.

However, it is probably not so bad as the suggestion of an open revolt would imply. Your correspondent, with nothing much to go on but general background and broad observation, still believes that the commission will send up its final report on the investigation in the very near future, but that it may well be in two pieces—meaning a minority as well as a majority version. There is even a possibility that it will go up to Congress in three pieces.

THE BIGGEST bone of contention probably centered in the quality of the evidence. If you were a member of the FCC, even though appointed after the hearings had been conducted, you might not like to sign your name to conclusions based upon evidence taken in a manner which you distrusted.

And since there was no opportunity for commissioners who felt that way to make independent investigation of their own, they were faced either with the alternative of washing their hands of the entire business and refusing to sign anything (which would put the commission, as a whole, in a worse light than ever), or of piecing together scraps from the staff evidence, the Walker report, and the Bell replies, according to their best judgment and hoping for the best.

The chances are that the dissident commissioners have decided on the latter course. If the difficulty over the major part of the final report—that is to say, the review of the facts and evidence—is thus breached, the commissioners ought to be able to surmount any obstacles over that part of the report which contains their conclusions and recommendations. After all, it is only necessary for dissenting commissioners to indicate their individual choice. But, of course, if there were a continued dispute over the validity of the basic evidence, it could have resulted in no report at all from certain commissioners—just as the newspaper stories hinted.

Another reason why all hands on the commission are likely to be laboring at the oars to get the final report out as soon as possible, is the forthcoming consideration by the House appropriations committee of the third deficiency bill which would include enough money to keep the FCC going for another year. It is not unlikely that the House appropriations subcommittee will want to ask the FCC a few questions on policy matters generally and if this final report were out of the way, the FCC's position before Congress would be considerably improved.

A final consideration would be the matter of personal courtesy to Commissioner Paul A. Walker, whose term expires at the end of this month, and whose chances of reappointment probably would be in-

creased if his principal accomplishment during his first term as a commissioner—the special telephone investigation—were *fait accompli* by the time his present term expires.

WITH the recent course of events in the House of Representatives, final hopes of the Independent telephone industry for obtaining additional relief from the wage-hour act (over and above the 500 station exchange exemption) should soon shift to the Senate side.

The defeat June 5 of Chairman Norton's motion for suspension of rules to give special consideration to her bill for amendment of the wage-hour act, leaves the House rules committee in present control of the situation. The rules committee is likely to grant a rule next week bringing up the Norton bill but making it subject to debate and further amendment.

The outlook is muddled but the chances favor a House victory by the farm bloc with the Senate approving the amended bill, which may have the telephone exemption raised above the present 500 stations.

All the administration leaders are now talking about July 15 as the date for adjournment of this session of Congress and most of the veteran newspaper men are adding another week to that date as a matter of habit. Some of the more cynical are even adding an additional week, just for good measure. It seems likely, however, that Congress will be out of Washington on or before August 1, which will give Congress two months to iron out differences.

Fortunately, there isn't much other legislation of a controversial nature. It looks now as if the administration has succeeded in stalling off substantial amendments to the National Labor Relations Act through use of the same tactics by which it has tried to stall off amendments to the Wage-Hour Act. Neutrality legislation, which is the principal threat to early adjournment, remains a question mark at this writing, with the odds being slightly in favor of no action at all.

The hope of the Independent telephone industry on the Senate side is the bill introduced by Senator Miller of Arkansas, mentioned in this department two weeks ago. This bill may never be voted on itself, but it gives Senator Miller and other friends of the small telephone companies an opportunity to use it as a lever for liberalizing House legislation on the subject in the Senate labor committee.

The Senate committee may simply incorporate the principle of Senator Miller's bill in the general wage-hour legislation and if the Senate passed it in that form, it is almost certain that the House side would yield to the Senate in conference.

Among other matters which the Senate will clean up during the remaining weeks of the session will be Senator Wheeler's resolution to investigate the telegraph industry. This was approved last week by the Senate interstate commerce committee and is expected to be approved by the Senate auditing board in time for a vote from the floor later this month. Since nobody has said a word in opposition, the resolution seems almost certain to be adopted.

Finally, there is still the matter of disposing of resolutions to investigate the FCC, which your correspondent continues to believe will be acted upon before the session is ended, whether in the House or the Senate, or both.

LAST WEEK the debate in the Senate over increasing the bond limitation of the Treasury pointed anew to the sky-scraping dimensions of our national debt—a situation which should command the attention of every business man, big and little.

The present legal limitation on Treasury obligations of all kinds is $45,000,000,000, and the present general debt of the United States government is a little more than $40,000,000,000 — as against $21,000,000,000 when the New Deal came into office. So, you can see that there isn't much margin left for the spenders, and you can understand why the administration would like to increase that margin before Congress quits.

The pro-spending school of Washington economists, which includes Marriner S. Eccles, head of the Federal Reserve, has done a fine job in making Senators relatively complacent about the size of this national burden (which, if collateral obligations were included, would be nearer to $50,000,000,000 than $40,000,000,000).

The pro-spenders insist that the way back to prosperity is for the nation to be spending $80,000,000,000 a year instead of $60,000,000,000, and that if private industry won't spend its share, the government ought to take up the slack.

The unfortunate angle of this hypothesis is that government spending is not only unproductive (which is to say nonprofitable in terms of liquid cash returns), but actually scares any proportionate increase in private business spending, which, by its very nature, must be productive (or profitable) to exist at all.

Reduced to simplified terms, the theory of the spending school is that if the nation will go out and get itself into enough debt, it will be forced to make enough money to pay off that debt—or at least keep up with it. This is the theory which some extravagant individual families try out on poor old Dad—the breadwinner. Sometimes it works; sometimes it doesn't. When it doesn't, both Dad and family will have to go to the cleaners; but should we take such a chance with the national credit?

THE SPENDERS put up some plausible arguments in the Senate last week: (1) The ease with which the government is able to float additional loans, at unprecedented low rates of interest; (2) they point to the fact that our per capita national debt is no bigger than it is in England—and even less than in other countries where currency control by government manipulation makes any statistics of doubtful validity; and (3) finally, they take full advantage of the *tu quoque* argument that certain Senators, who talk economy, vote against it in specific legislation in which the interests of the constituents are involved.

All of these arguments were pretty well disposed of by the opposition, but it is doubtful whether any good will come of it other than general education on financial housekeeping, to which the federal government may pay some attention some day.

First, there is the undisputed fact that the government's ability to float loans at increasingly low rates of interest is, in large measure, the very result of a most unhealthy flight of capital away from private enterprise and into the investment in tax-exempt securities.

The investor knows that the more the government spends, the more the government must tax, and the heavier the burden private business must bear. The investor knows that by buying government securities instead of the increasingly perilous securities of private business, he puts himself on the receiving end rather than the paying end.

Viewed in this light, the ability—indeed, the audacity—of a spendthrift government in allowing affairs to get into such a condition that the federal Treasury becomes more and more successful in luring the investors' dollars out of the stream

(Please turn to page 33)

NEW IDEAS AND SHORTCUTS

for Plant and Exchange

By RAY BLAIN

WHAT is your "pet kink" or best method of doing a certain job? Why not tell others through this new department?

The Value of Catalogs

The great value of manufacturers' catalogs to the Independent telephone industry is well known. In addition to listing all necessary materials, the catalogs also explain their uses. Valuable specifications on such materials as cable and poles are included, and such items as switchboards and telephone instruments are explained in detail.

Our telephone catalog library contains numerous volumes and they are all kept carefully filed so that any one can be located quickly to obtain desired information. Not only are the new catalogs maintained carefully but an old one is never thrown away. The old catalogs are often valuable in looking up information on old apparatus still in use but not listed in the new catalogs. A separate file is kept of old catalogs as they are not referred to with the same frequency as the new ones.

The various manufacturers and suppliers of the Independent telephone industry go to considerable expense to furnish these valuable catalogs. Therefore, we should appreciate them sufficiently to maintain them carefully and to use them to the best advantage.

The Hanging Type Handset

The hanging-type handset has proved very convenient for certain types of service. This instrument may be installed on a desk so that it is much more out of the way than the ordinary type. It is especially useful for mounting on a small typewriter desk where a stenographer is required to answer a telephone, either a part or all of the time.

The hanging type handset meets many special telephone needs. Note the neon bulb, which lights from the ringing generator when the bell rings.

A flexible-type cord is especially adapted to use on this style instrument. It forms a short loop and does not hang near the floor as does the conventional type cord and thus does away with the danger of passers-by catching a foot in the cord and tripping themselves.

Contrary to the general belief of some, a dial may be easily installed and conveniently used on the hanging-type handset. We sometimes use a neon-bulb, which lights from the ringing generator when the bell rings. Thus two closely-associated telephones may be easily distinguished. Many could profit by investigating the use of the hanging type handset. Generally those giving this instrument a trial like the idea.

Catalogs of manufacturers and suppliers prove of real benefit to the Independent telephone industry.

Sealed-type glass jar storage batteries mounted on rack.

Modern Storage Batteries

Old timers will agree that telephone storage batteries have been greatly improved during the past few years. The old-style open cells while quite efficient, were also sloppy and rather difficult to maintain and keep clean. They also had to be installed in a ventilated cabinet to prevent escaping gas from injuring nearby equipment.

The new, sealed-type, glass-jar batteries are neat and clean. They need not be installed in a cabinet, although some companies continue to follow this practice, unnecessarily, through force of habit. A very neat and clean installation is to place such batteries on a rack made from 4-inch by 4-inch timbers, fastened together with bolts and well covered with aluminum paint.

The sealed glass jar batteries may now be obtained in two and three-cell

units which simplifies their installation as fewer connections between cells need be made on the job. Charge indicators are built into the cells which makes their maintenance a simple matter.

The evaporation of water from the electrolyte in a sealed-type cell is greatly reduced over the old open-cell variety, except when the battery is excessively overcharged. Any telephone company now using an old rundown storage battery will do well to investigate the new, sealed glass jar types.

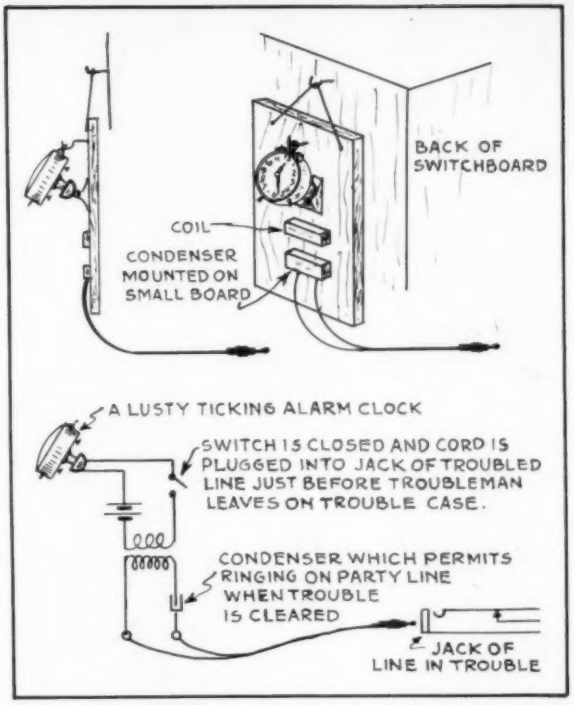
Handling Heavy Poles

The handling of long, heavy poles can be a most difficult and dangerous task when proper equipment is not available. However, when the necessary equipment is used, the job may be performed with comparative ease and safety. By large, heavy and long poles are meant poles with lengths of 90 to 100 feet and weighing 5,000 pounds or more. Everyone will agree that the moving of such poles ordinarily represents a real task in any telephone exchange.

When a pole trailer is used for moving such heavy poles, the first thing to be accomplished is to load the poles on the trailer. This may be accomplished in one of several different ways:

A pole derrick may be used to elevate the pole while the trailer is run under it. When a construction truck is provided with the arrangement whereby the crossbar may be elevated to the top of the body, the winch line can be placed over a sheave on it. Usually proper elevation can be gained on the pole so that the trailer can be run under it without the use of the pole derrick. Or a skid may be placed on the trailer and the pole rolled up it with a rolling-hitch from the winch line. Either method will prove satisfactory when properly used.

The pole should be placed on almost a perfect balance on the trailer. We make use of a short length of messenger strand and a chain hoist to bind the load on the trailer. A drawbar hitch proves a real advantage for attaching the pole to the pintle of the truck for hauling.


BACK OF SWITCHBOARD
COIL
CONDENSER MOUNTED ON SMALL BOARD
A LUSTY TICKING ALARM CLOCK
SWITCH IS CLOSED AND CORD IS PLUGGED INTO JACK OF TROUBLED LINE JUST BEFORE TROUBLEMAN LEAVES ON TROUBLE CASE.
CONDENSER WHICH PERMITS RINGING ON PARTY LINE WHEN TROUBLE IS CLEARED
JACK OF LINE IN TROUBLE

A new testing idea has been used successfully at Riley, Kans., whereby an alarm clock is hung in front of a transmitter and its lusty ticking provides a clear tone out on the line.

Alarm Clock Used for a Trouble Tone

Secretary H. B. Couch, of the Kansas Telephone Association, submits a testing arrangement which has been successfully used for a number of years by Chas. E. Reece, owner of the Riley Rural Telephone Co., Riley, Kans. A trusty alarm clock of the husky variety, used to supply a tone, has been found most useful in the testing for trouble and clearing conditions to improve transmission on a line. The clock is hung in front of a transmitter and its lusty ticking provides a clear strong tone out on the line.

A transmitter, repeating coil and condenser are mounted on a board about 4 inches wide and 8 inches long. One winding of the coil is connected with a battery, switch and transmitter in circuit. The other winding of the coil is connected through a condenser to an ordinary switchboard plug and cord. The alarm clock is hung from a hook so its back rests on the transmitter mouthpiece and the board is hung on the end of the switchboard.

The plug is placed in the jack of the line in trouble and the switch closed to close the transmitter circuit. When the line is clear, the ticking of the clock will be clearly heard by the troubleman without calling a subscriber or the operator to make sure that the line is clear.

After the trouble has been cleared, this testing arrangement will not prevent calling other telephones on a party line. This is an inexpensive testing arrangement which, no doubt, other small telephone companies will find useful.

Loading a heavy pole on a trailer by the method of rolling it up a skid with the winch line.

Method of using a drawbar hitch to attach trailer load of telephone poles to a truck.

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CLIMBERS
"Klein" climbers are individually tested and tempered, and set at correct angle for greatest safety

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standard or long hook
button head, as requ

POLES
Pine and cedar poles of uniform high quality. Processed with the latest approved types of treatment

R THE TELEPHONE PLANT

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Gloves of genuine horsehide leather will protect fingers and thumbs and insure greater safety

"NICOPRESS" TOOLS
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SAFETY BELTS
"Klein" safety belts enable your linemen to do better work with greater speed and safety

DROP WIRE
"Monotype" drop wire with the COPPERWELD conductor combines great strength with high conductivity

E STEPS
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INSIST UPON AUTOMATIC ELECTRIC HIGH QUALITY SUPPLIES FOR TROUBLE-FREE, DEPENDABLE SERVICE!

When your linemen go out to put up a new pole line—to repair storm damage— or to do necessary maintenance and check-up work—what kind of tools and materials do you give them?

Have you taken a chance with their safety by providing them with an inferior type of safety belt? Are you risking the failure of important, heavy-traffic lines because the line wire used is of doubtful quality? Will you wake up a few months from now to find that those insulators which seemed such a "good buy" were as low in quality as they were in price, and will have to be replaced?

Automatic Electric believes that even for the smallest company, good quality supplies and construction materials are the cheapest in the long run. That's why all of the supplies we handle are fine quality products of nationally known manufacturers—products that we can pass on to you with the assurance that they will give a full measure of long life and trouble-free, dependable service.

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An Event Is Celebrated in Johnstown, Pa.

COMPLETION OF NEW building and installation of largest all-relay dial equipment in world was marked by cut-over inspection and reception attended by many prominent officials of operating and manufacturing companies

THE NEW ULTRA-MODERN central office building of the Pennsylvania Telephone Corp., in Johnstown, Pa., and its all-relay, dial type equipment—the largest installation of its kind — were subjected to the admiring eyes of approximately 125 officials of telephone operating and manufacturing companies on May 22. They came from many points of the country to attend, as invited guests, a cut-over inspection of the building and equipment and a reception later. Many were the compliments received by the company's officials concerning its new building and exchange equipment.

The three-story building — from the air-conditioning equipment to the emergency power plant — was completely ready for the close inspection. The cleanliness of the rooms and the quietness of equipment in handling traffic were subjects of many comments. The three-story and basement building, approximately 100 feet by 130 feet, has glass brick panels in place of windows. The actual cutover took place on the night of April 22, involving approximately 12,000 telephones in the city of Johnstown, and practically no trouble was experienced.

During the inspection hours from 10 a.m. to 12 noon, May 22, the guests were proudly greeted at the entrance by H. M. Engh, vice-president and general manager of the Pennsylvania Telephone Corp. After registering they were conducted through the entire building in groups of five or six by competent guides who were thoroughly qualified to answer all questions about the modern equipment.

The inspection trip started on the first floor, where is located the dream of every telephone manager—beautiful commercial quarters with a spacious lobby, plenty of room for the public, private rooms for customers' use and general office space for the commercial department employes.

From the commercial offices the visitors were shown the modern service-observing switchboard. The board is located on the first floor so that continual and uninterrupted checks can be made on the local as well as on the toll service. Well-appointed offices for the plant department and a readily accessible cable vault take up the balance of the first floor space.

The basement contains a fully-equipped garage, capable of accommodating all of the company cars and trucks and providing a complete storeroom for outside plant materials as well as safe storage for station and P.B.X. equipment. The storeroom is platform-high above the garage floor so the installation cars and construction trucks can be backed up to the platform and loaded efficiently.

The second floor contains all of the

Observation desk in the new building at Johnstown, Pa.

The information desk is completely up-to-date.

central office equipment, including the North Electric dial equipment which is said to be the largest installation of all-relay equipment in the world. Laid out so as to provide efficient handling of service in well-lighted working quarters are the toll and assistance switchboard, the test center, power plant and operators' quarters.

In line with the present trend to design buildings and equipment so that dangers of service failures are materially lessened, the second floor of the building is well above flood level so that operation of the central office equipment can be maintained throughout a flood.

The third floor contains an emergency power plant which may be operated on either gas or gasoline. This power plant, when operating on gasoline, will provide power for the telephone equipment and the essential building operations in case of a flood or other emergency. Also on the third floor is the ventilating and air-conditioning equipment. Through the use of this equipment the air is filtered, heated in cold weather, cooled in warm weather, and held at the proper temperature and humidity for the comfort of employes in the building.

The officials of the Pennsylvania Telephone Corp. did not stop their earnest endeavors to be good hosts to their large number of guests with the inspection of the building. After the inspection was completed a reception followed by a luncheon was given at the Fort Stanwix Hotel. Charles H. English, attorney for the Pennsylvania Telephone Corp. and member of the law firm of English, Quinn, Leemhuis & Tayntor, Erie, Pa., capably acted as toastmaster.

During the "after-inspection" fes-

←This view of the toll board and chief operator's desk, with posture chairs, pictures the modernness of the new equipment installed in the Johnstown, Pa., exchange.

Battery room in the air-conditioned exchange at Johnstown.
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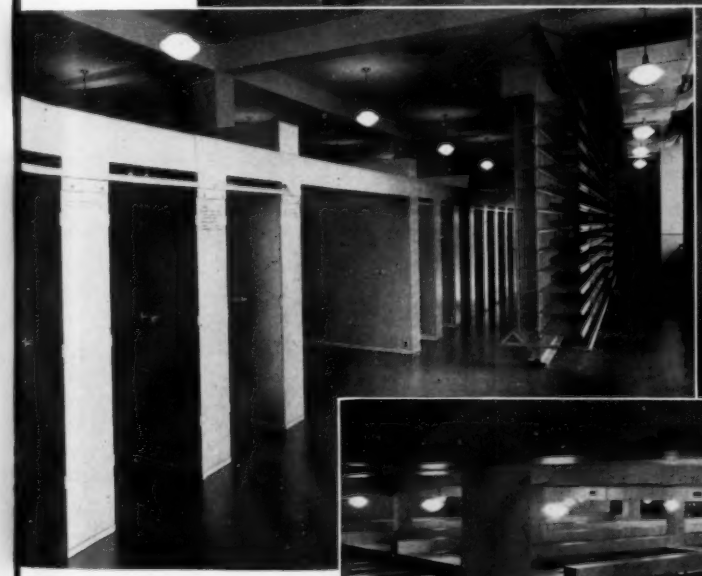
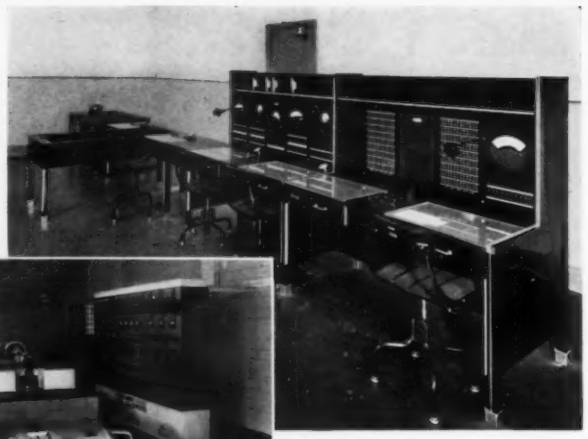
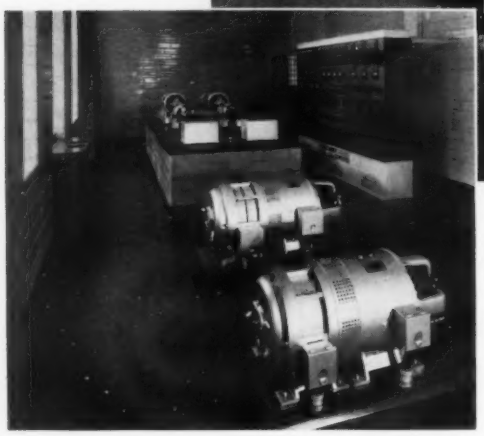


Above may be seen the distributing frame and cabinets containing the North All-Relay switching equipment in the Johnstown exchange. To the right is shown a top view of the switchboards.

Wire chief's → desk and repair desk in the new exchange building at Johnstown, Pa.





←The power room in the new Johnstown exchange building is located on the second floor well above flood level, thus assuring continued operation of the central office equipment throughout a flood. On the third floor is an emergency power plant.

tivities Mr. English gave a resume of the events culminating in the dial cutover including the consolidation with the local Bell exchange, which was consummated in the early part of 1938.

Mr. English then presented the following speakers: Fulton I. Connor, president of the city council of Johnstown who represented Mayor Shields of Johnstown; John Winn, president of General Telephone Corp., New York, N. Y.; F. J. Chesterman, vice-president of the Bell Telephone Co. of Pennsylvania; W. H. Meyers, member of the building architects, Meyers & Johnson, Johnstown, Pa.; John F. Wilson, president, Wilson Construction Co., Johnstown, Pa., which erected the building.

F. R. McBerty, president of the North Electric Mfg. Co., Galion, Ohio, which designed, furnished and installed the central office equipment; and Harry M. Engh, vice-president and general manager of the Pennsylvania Telephone Corp., Erie, Pa.

All the responses were brief and dealt with some phase of the building, equipment or operation. All arrangements for the inspection and reception were well carried out and every one of the guests expressed sincere appreciation of the opportunity to view the new exchange building and equipment.

Undoubtedly the Johnstown exchange will be visited from time to time by engineers and operating officials interested in building design and also to observe the operation of such a large installation of all-relay, dial type equipment.

▼ ▼

Telephone Practice and Problems in South Africa

By Walter Buchler

Until recently iron or steel poles were used exclusively for carrying telephone and telegraph wires both in towns of South Africa and throughout the country. While the iron and steel poles remain the standard for heavy construction, it is now the practice to use treated wood poles for country lines where the ultimate load will not exceed eight wires.

The conductor used for farmers' 10-party telephone lines is 200 pounds per mile galvanized iron. For trunk lines copper wire, 150, 200, or 300 pounds per mile is used, depending on the class of service catered for.

Owing to the distances involved, transportation costs are heavy, but motor haulage has greatly accelerated the rate of progress. Rocky ground and scarcity of water in many parts of the country are factors which have to be taken into account. All country maintenance electricians are supplied with motor transport, at the government Post Office expense, to facilitate the rapid removal of faults.

Thunderstorms are very severe and lightning is probably the principal cause of line interruptions. Insulators are frequently smashed to pieces and wires are burnt as the result of lightning.

In parts of the country which are largely treeless, large birds build their nests on the telephone poles and odd pieces of wire are included in the make-up, with disastrous results to telephone communications and also, incidentally, to the nest-builders. In certain localities a small bird known as the weaver bird hangs its nest on the wires, but this rarely interferes with communication.

The use of underground cables is confined to the telephone exchange systems with their associated junction lines. The maximum capacity at present in use is 1,400 pairs of 6½-pound conductors.

Carrier telephone and telegraph systems over open wires are extensively used throughout the country.

Most of the major telephone exchanges are now on an automatic basis. Standard Strowger equipment is used, the system on the Witwatersrand being on the "Director" six-figure principle and the others being what is known as the "straight Strowger" with five-figure dialing. The telephones associated with the automatic exchanges are of the latest pattern with moulded handsets.

The less important exchanges are of the magneto type, the telephones associated therewith being equipped with 200-ohm ringers and powerful generators. The party-line service is in use in the rural areas—up to 10 stations are accommodated on one line.

Conditions affecting maintenance vary considerably. Dust is prevalent at inland centers, while at the coast extreme humidity is a heavy factor. Air-conditioning is employed to combat both conditions.

▼ ▼

Freak Accident Occurs Despite Precautions

Despite warning signs, "Men Working," flag in holder on pavement, and a man flagging about 150 feet away from a telephone construction truck, a freak accident happened recently on U. S. highway No. 20, about 1½ miles west of Harmony, Ill.

A line crew for the Illinois Bell Telephone Co. was doing some work along the highway. The men were replacing one pole when another, two poles away from the one on which they were working, toppled over into the highway. The pole struck the pavement and the crossarms hit the top of the car of Mrs. A. J. Alexander of Elmhurst. The machine was damaged but she escaped uninjured. Traffic was delayed for a short time until the pole was removed from the highway.

New Lead-Covered Telephone Cable Contains 4242 Wires

ENGINEERS of the Bell System have made another historic advance with the manufacture of cable containing 4,242 separately-insulated copper wires. Heretofore, the maximum contained in one cable was 3,636 wires. Despite the increase in the number of wires, the new cable is no larger around than its predecessor, its diameter being exactly the same—2⅝ inches.

Since the diameter of each wire in the new cable is also the same as before, the feat of placing 606 more wires within the same girth was made possible by an improved technique of wire insulation invented by the Western Electric Co., a method which reduced the thickness of the insulation surrounding each strand.

There was thus produced a covered wire with a diameter of 31/1000ths of an inch, compared to the former diameter of 34/1000ths. The decrease in each case was only 3/1000ths of an inch but this tiny saving, repeated 3,636 times, resulted in a total saving of space sufficient to afford room for the additional wires.

The use of a cable core composed of wires so closely packed together was, in turn, made possible by refinements in the science of transmission and in the telephone instrument itself, achievements of Bell Telephone Laboratories.

The first installation of the new cable took place when 14,000 feet of it, manufactured at the Kearny, N. J., works of the Western Electric Co., were installed by the New Jersey Bell Telephone Co. in the Jersey City area.

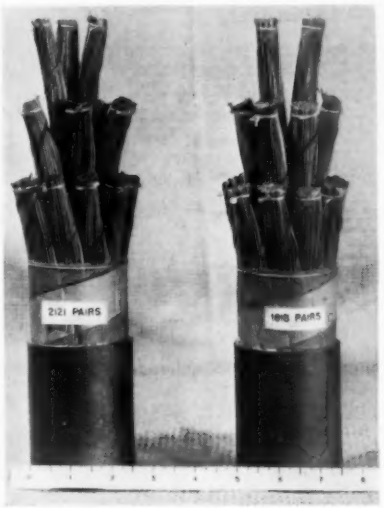
The method of insulating the wires of the new cable is in itself a revolutionary development of the last decade. Previous to the invention of this process, wires intended for cable had been insulated by wrapping paper ribbon spirally around them. Then it was discovered that paper pulp could be formed around the wire. Now giant machines literally manufacture a thin coating of paper right on the wire, 60 strands at once, as they pass through a bath of pulp.

The cable core of 4,242 conductors is built up from these individual strands by first twisting two wires into a pair, then binding 101 of these pairs into a unit. Finally, 21 of these units are twisted together, and the core, after being dried out in vacuum ovens, is sheathed with lead that is forced through dies under great pressure.

The history of telephone cable goes back about 60 years, when telephone lines first had to cross rivers on bridges, through tunnels, or even on the bed of a stream. In 1881 special studies of cable were begun by Bell engineers on the recommendation of far-sighted Theodore N. Vail, then general manager of the American Bell Telephone Co. Early efforts were not crowned with success, however, for it was discovered that one mile of underground cable cut down transmission efficiency as much as did about 30 miles of open-wire line.

At first the infant telephone art turned to the older telegraph and adopted its use of rubber and gutta percha for insulation. This proving unsatisfactory for voice transmission, oil insulation was substituted. In one instance, each one of 20 wires was enclosed in a glass tube surrounded by grease and rosin. Then came cotton covering, impregnated with paraffin.

A skilled operator fastens the 4242 conductors together in preparation for the exacting insulation test given to each wire in the cable before it acquires its lead coating. If any pair of wires is found to be imperfect, a detector scouts along the cable to the exact spot where the leak occurs.



A piece of the new cable (left) and its most populous predecessor (right). The bottom section shows the complete cable enclosed in its lead sheath. The section above, labeled with the number of wires, has had its lead sheath removed and shows the spiral wrapping of paper enclosing all the wires. Above that are seen the units composed of 101 pairs each, the new cable containing 21 such units, the other 18.

A length of 2121-pair cable is shown being unwound from a huge reel for the first underground installation in Jersey City last month. Once the cable is in its place, splicers begin the work of connecting each of 4,242 strands with its proper mate in the next length of the lead-covered cable.

When, in 1890, it was found that lead sheaths could be so applied as to exclude water, the need for an insulating compound ceased to exist, and paper-insulated dry-core cable made its appearance.

Perhaps the greatest contrast between old and new methods of cable manufacture is to be found in the early manner of applying the lead sheath. The antecedents of the swift and sure lead presses of today were ex-sailors. To the accompaniment of their chanted "Heave Ho," the core was actually pulled through lengths of lead pipe by hand. Plumbers were then called in to "wipe the joints" and make one continuous lead pipe out of the various sections. Lead presses made this procedure obsolete shortly before 1900.

Early wires were generally larger in diameter than those used today, and the number that could be accommodated within one sheath was greatly limited. Producing thinner wires would have been a simple enough solution, but to use them without the sacrifice of transmission efficiency offered a distinct challenge to engineers—one that is still being met.

However, as more efficient transmitters, receivers and other apparatus were developed, the need for large wires diminished. In 1892, for instance, the largest cable in commercial service contained 101 pairs. Their conductor size was 18 gauge, 1/25th of an inch in diameter, whereas the wire used in the new 2121-pair cable is 26 gauge—less than 1/60th of an inch.

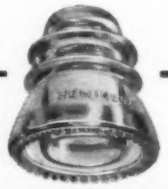
Milestones in the history of cable: The lead-covered cable of 1888 carried 100 wires, doubly-wrapped in cotton insulation and dipped generously in paraffin. The entire mass of wires was pulled by hand through lengths of jointed lead pipe, which were then filled with paraffin to complete the cable. Although the 1890 cable was also pulled through lead pipe, spiral paper insulation did away with the clumsy cotton wrapping. Hydraulic lead presses were introduced a few years later to put the final covering on cable instead of using jointed lead pipe. By 1914, 1212 pairs of paper-covered wires were enclosed in lead sheathing. The concentric layers of wires, like the annular layers of a tree, may be easily seen. By virtue of smaller wire size, cable capacity was increased further to 1818 pairs in 1927. The fundamental change in cable making during the last few years has been the process of putting paper pulp insulation directly on each wire. Engineers were thus able to crowd in some 600 more wires to make the 2121-pair cable of 1939.

By 1901 the use of 22 gauge made possible 404 pairs. The following year 202 more pairs were added, and in 1912 the Western Electric's Hawthorne plant in Chicago was turning out short lengths of 909-pair cable.

Conductor wire underwent another slenderizing process in 1914 and 24 gauge was used in cables containing up to 1212 pairs. Today's thread-like 26 gauge made its debut in 1928 with the 1818-pair cable.

Up until that year the stranding technique had consisted of twisting layer after layer of wires, outward from the center, like annual growth rings are added to a tree trunk. However, it was noted that each increase in the number of pairs in a new cable resulted in a corresponding sacrifice of the cable's handling qualities. This was recognized as a serious obstacle in the path of cable progress, since the ease with which lead cable can be bent is of paramount importance in installing it.

Experiments showed that the solu-



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Owens-Illinois Glass Company, Muncie, Indiana.

tion lay in a variation of the stranding technique known as the "multiple unit" method, in which the wires were grouped in sub-cables of 101 pairs each. These smaller units made for less friction between the component parts of the core, and the completed cable could, therefore, be more easily handled. With this advantage came others: electrical efficiency was improved and less tension was exerted on the comparatively delicate wires in the stranding operation.

Nimble fingers of trained workmen of the New Jersey Bell Telephone Co. at work splicing 2121-pair cable in the cable vault of a central office in Jersey City.

This stranding method, together with the revolutionary pulp insulating principle, set the stage for the present 2121-pair achievement.

Cost figures also illustrate the value of the increase in cable conductor capacities. For instance, the 50-pair cable which was standard in 1888 cost more than $150 a mile per pair installed, while the cost of the new 2121-pair cable installed is less than $10 per pair mile.

▼ ▼

Ordinary Cable Used in Television Test

Engineers of the National Broadcasting Co. in New York City televised publicly over an ordinary telephone line for the first time on Saturday night, May 21. The telephone wire hook-up, from the bicycle races in Madison Square Garden to the NBC studios in Radio City, by way of the New York Telephone Co.'s Circle exchange at Ninth Avenue and Fiftieth street, was a little over a mile long.

Previously the telephone wire had been used only for short distances in laboratories. Otherwise costly coaxial cables have been regarded by engineers as the only type of a wire channel that could be used effectively to transmit a television image.

The cost of the experimental coaxial cable from New York to Philadelphia, a distance of 90 miles, installed more than a year ago by the Bell Telephone Laboratories, is reported to have been $500,000.

The telecast over the telephone wires May 21 was made possible by the development of amplifiers by Bell engineers. The engineers emphasize that the program was strictly experimental and that the success of the telecast did not warrant a prophecy of national television networks on the basis of telephone wire circuits. One of the benefits of the telecast, engineers said, was that it proved a theory possible.

After the images were received in the studios they were conveyed over an axial cable to the transmitter in the tower of the Empire State Building and from there sent out over the air. Observers who saw the images in studios were impressed with the breadth of view. They said they saw all the bicycle riders from one end of the Garden to the other.

While success in transmitting the television images was described by broadcasters in New York City as of "tremendous significance," telephone engineers warned against false hopes that the nation's telephone wires can be so adapted as to make possible a coast-to-coast television network.

"Theoretically it is possible to select an ordinary wire channel across the continent, bolster it up with repeaters every mile or so, add equalizers, and make it carry a television picture," said Dr. Frank B. Jewett, president of the Bell Telephone Laboratories, Inc. "But why spend a 'king's ransom' on a telephone wire for such a purpose when eventually other means, say radio or coaxial cable, will be available to do it better?"

Dr. Jewett explained that ordinary wires for television pick-up seems likely to be limited to about five miles; the link between the Madison Square Garden and Radio City was a mile and a half. He believes that in cities, where the use of radio waves is precarious because of multiple images caused by wave reflections from buildings, and where coaxial cables cannot be laid to cover every possible pick-up, the telephone wire is the answer, but "any old wire will not do for television."

This unprotected cable terminal is sturdily constructed of high-grade iron, heavily galvanized. The snugly-fitted zinc hood is reversible, permitting the cable to be carried out from either the top or bottom, as desired. Mounting bracket is detachable, providing for easy mounting. Ample space is provided for easy access to the leads. Send for further information on this and other Sands protective devices.

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The Operators' Corner

By MAYME WORKMAN
Traffic Supervisor, The Illinois Telephone Association, Springfield, Ill.

WHAT WOULD you consider good toll service?—No. 368

CERTAIN essentials are necessary to any service if it is to come under the classification of "satisfactory service from the customer's viewpoint." Telephone service is no exception to this general rule.

As operators, what kind of service do you like to receive when you place a long distance call? If you will seriously analyze this question, you will be reasonably sure to have the answer to "What constitutes satisfactory service from the customer's viewpoint?"

When an operator is at the "sending end" of a long distance call, she is very much like the average customer. A little more exacting, perhaps, and strange as it may seem, in some instances less patient, if anything goes wrong on the call or a delay is encountered.

When an operator places a long distance call she appreciates and expects a prompt and courteous answer. This not being forthcoming, she displays impatience, sighs and wonders what is wrong with the girls at the office. All the thoughts that flicker through the customer's mind when he is given the same treatment are there; perhaps more vivid because of the operator's familiarity with what might be responsible for the delay.

If an operator has occasion to place a long distance call in another city, she is very observing of the operator's voice and manner, her speed of service, phraseology, operating routines, and all the many things which when combined spell "Satisfactory telephone service from the customer's viewpoint."

If another operator's voice displays hurry, lack of interest or irritation, the operator placing the call may think or say: "Well, I wonder what's wrong with Mary this morning?" Or if she is placing a call in another city, she may say: "This operator surely isn't up on *her* voice work."

If, after the operator's call has been placed, she hears nothing more after the acceptance of the call—just silence—she has the average customer's reaction; shifts from one foot to another. If she is in a booth, particularly in the summer time, she says: "Is it ever hot in here! I wish that operator would hurry." Will she never get that call through? I wonder if she is working on it?" Finally, in nervous desperation she begins to jiggle the receiver hook. Such reactions prove that—"the customer does like to hear the advancement of his call."

How does an operator feel when she reaches a wrong number? Need we go into that? Again, her reaction to having some one say, in an irritable tone of voice, "No, you have the *wrong* number," accompanied by the disagreeable bang in the ear which frequently follows, when the receiver is placed on the hook in no gentle manner, is that of the average customer. If she gave her order clearly and distinctly, she will also feel aggrieved because the operator failed to understand her order.

In summing up, the three essentials to good service, from the customer's viewpoint, remain the same: "a courteous, pleasant answer, and reaching the right number as quickly as it is humanly possible."

Questions from Illinois Operators

1. What are the basic requirements of good toll service from the customer's viewpoint?
2. What is the proper way to announce a long distance call?
3. Is it necessary for the toll center operator to announce her station name in completing a long distance call?
4. When a person who is not a subscriber makes a call, promises to pay for it and then does not do so, should the operator let him have other calls?
5. Is it necessary to ask the name of the calling party on calls to nearby telephones? The phrase seems to call for it.

The answers to these traffic questions are given on page 29.

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Commission and Court Activities

Wage-Hour Amendment Activity in Congress

Some progress towards action on the amendment of the Wage-Hour Act by Congress was made this week in the House. The motion by Chairman Norton of the House labor committee, for suspension of rules to give special consideration of her bill amending the Act, was defeated June 5 by a vote of 167 to 110, the necessary two-thirds majority for passage not being obtained.

The defeat of Mrs. Norton's motion leaves the House rules committee in control of the situation. This committee is favorable to the agricultural bloc which opposed Mrs. Norton's motion. It is likely that the committee will grant a rule next week to bring up the Norton bill but allowing debate and further amendment.

The wage and hour committee of the United States Independent Telephone Association is closely watching the various moves being made and expects that the bill with the amendment exempting the small telephone exchanges will come up for a vote in the House within the next two weeks.

The full committee held a meeting in Chicago June 6 to discuss the situation. Chairman J. H. Agee of Lincoln, Neb., was to go to Washington later in the week and the committee will meet there soon to further action on the telephone amendment.

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New Suit Filed in St. Paul, Minn., Case

A new suit, contending that under the new rate schedule retroactive to June 1, 1936, for the St. Paul and Minneapolis, Minn., areas, subscribers should get back money paid by them when they failed to take advantage of discount periods, was filed May 22 in the district court of Ramsey county.

Involving possible refunds totaling $500,000, it was the second of two actions involving the recent rate reduction order of the Minnesota Railroad & Warehouse Commission. The first was a formal request to Attorney General J. A. A. Burnquist to void the commission's "compromise" rate order which lowered the rates of the Tri-State Telephone & Telegraph Co. in St. Paul and of the Northwestern Bell Telephone Co. in Minneapolis. The new telephone rates embodied in the compromise rate cut order have gone into effect in the Twin cities and represent a reduction of about 12 per cent.

The second suit was brought against the Tri-State Telephone & Telegraph Co. by R. W. Krohn, M. L. Ryan and L. L. May, all of St. Paul, in behalf of themselves and "other affected subscribers." It was filed by John T. Kenny and Lewis E. Lohmann, attorneys.

The action is based on the company's practice of permitting deductions from telephone bills when the bills are paid before certain dates.

▼ ▼

Master in Oklahoma Rate Case to File Report

Frank M. Bailey, Chickasha, Okla., is expected to file his report, this week, as special master in the case pending in federal court between the Oklahoma Corporation Commission and the Southwestern Bell Telephone Co.

The case involves efforts by the telephone company to increase exchange service rates in 14 Oklahoma cities. Both sides presented evidence to Mr. Bailey for several weeks. The special master's report will be made to a three-judge federal court.

▼ ▼

Nebraska Companies Not Affected by Legislation

The Nebraska legislature adjourned June 7, but among the 140 bills that it enacted into laws not one adversely affects the telephone industry.

The interests of the industry were carefully looked after by Secretary Geo. M. Kloidy and other officers of the Nebraska Telephone Association, assisted by representatives of the larger companies in the state. A dozen bills were introduced that would have had more or less direct application to the industry, but none of them reached the floor of the legislature.

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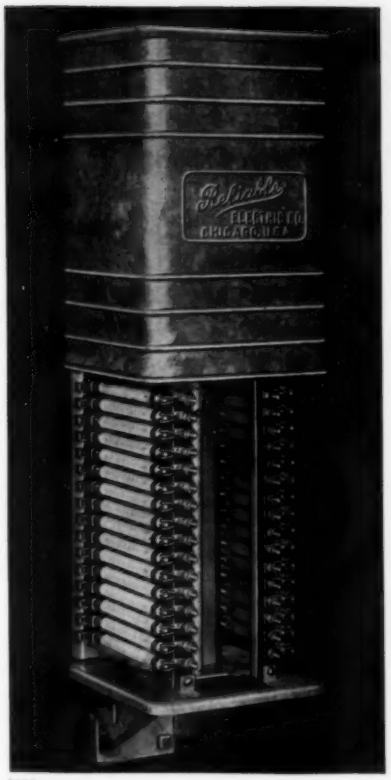
Summary of Commission Rulings and Hearings

Alabama Public Service Commission

May 17: The Southern Bell Telephone & Telegraph Co. ordered to discontinue the monthly extra charge for handset telephones. The order is effective with the April billings.



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Illinois Commerce Commission

June 6: Hearing in Springfield on the commission's citation, on its own motion, against the Illinois Bell Telephone Co. to show cause why an order should not be entered requiring the Illinois Bell to construct and install telephone facilities and render service in River Oaks, West Cottage Hills, North Cottage Hills, South Cottage Hills and Fairfield subdivisions and territory adjacent thereto in Fosterburg township, Madison county.

June 6: Hearing in Springfield on the commission's citation on its own motion against the Worden Telephone Co. regarding the failure to file annual report with the commission for the year 1938.

June 6: Hearing in Springfield on the commission's citation on its own motion against the Forest City Telephone Co. regarding the failure to file annual report to the commission for the year 1938.

June 6: Hearings in Springfield on joint petitions of the Illinois bell Telephone Co. and the American Telephone & Telegraph Co. for approval of lease agreements covering certain facilities in Joliet, Watseka, Ottawa, Wyanet, Decatur, Springfield, Peoria and Champaign.

June 7: Continued hearings in Springfield on applications of the Illinois Commercial Telephone Co. for authority to increase rates in Coulterville, Bethany, Chatsworth, Bradford, Evansville, Low Point, Washburn and Fairbury.

A protest was filed by Mayor George Thomas and others against increased rates at Coulterville, and the village of Chatsworth filed objections against an advance in telephone rates.

June 7: Hearing in Springfield on application of the Altona Farmers Telephone Co. for authority to increase rates for service in Altona.

Michigan Public Service Commission

June 8: Hearing in Lansing on application of the Public Service Telephone Co. of Montrose for authority to incorporate.

June 8: Hearing in Lansing on application of the Public Service Telephone Co. of Montrose for a certificate of public convenience and necessity.

Minnesota Railroad & Warehouse Commission

June 12 and 13: Hearing on application of the Minnesota Community Telephone Co. to increase its rates in Arlington, Belle Plains, Jordan, Henderson, Green Isle, Le Center, Elysian, Montgomery and Janesville.

Nebraska State Railway Commission

May 26: Application of the Nebraska Continental Telephone Co. for authority to revise tariffs at its exchanges in

Curiosity

By ANNE BARNES

Traveling Chief Operator, Iowa Independent Telephone Association, Des Moines, Iowa

"EVE with all the fruits of Eden blest, save only one, rather than leave that one unknown, lost all the rest."—Moore.

Well, Eve got the world off to a good start in one thing anyway. Looking at it this way: Many a fine achievement owes its first impulse to curiosity's cravings. Every advance into more knowledge opens the way into further progress.

Curiosity is prompted in more ways than desire alone for knowledge, for further achievement. For instance, a certain kind of curiosity is prompted by desire to ferret into the affairs of others. It is an abominable trait in people. Such persons do not crave to know the affairs of other folks for themselves alone; they want the information to peddle it about. Thus they become not only curiosity-seekers but also carriers of gossip—a bad combination.

Mary Jones had been transferred from the Crystal City exchange to Hocum to succeed Hetty Stone. Hetty, like Eve, lost all, rather than give up the idea of satisfying her taste for the fruit of curiosity. People liked Hetty Stone—in a way. And they didn't like Mary Jones—in a way. Hetty was a hometown girl; Mary was from Crystal City. That's the answer—in a way.

"That new operator is a cold proposition. She isn't interested in the affairs of a small town. She's from Crystal City. 'I haven't heard,' is all you can get out of her; and I know very well she does know!'" These and similar remarks seem to be the popular refrain at card clubs and such.

But once in a while someone pipes up—"The difference between the girls is this: Hetty knows us like a book, and Mary doesn't, as yet, make our private affairs her business."

MORAL: "Curiosity is *looking over* other people's affairs, and *overlooking* our own."—Wayland.

ANSWERS TO TRAFFIC QUESTIONS ON PAGE 26

1. Please refer to preface.
2. On a station-to-station call, say "One moment, please? (calling place) is calling (address, name or No.)." On a person-to-person call, say, for example: "Mr. Hill, please? Streator is calling."
3. Yes. This procedure is followed in order to identify the call as a long distance call in order that the called office operator will pass a "don't answer" report if the called station is slow in answering.
4. This question should be referred to your manager and you should be guided by his instruction.
5. If the calling party specifically requests that you reach a nearby telephone for the purpose of requesting them to notify a called party to come to the telephone, it is necessary to secure the name of the calling party in order to tell the person who answers that the request to call the called party to the telephone was made by the calling party.

Albion, Battle Creek, Bloomington, Burwell, Genoa and Tilden—being in the nature of unification of charges and operation—granted as asked.

May 27: The Lincoln Telephone & Telegraph Co. authorized to use for its 1939 operations a depreciation rate of 3.5 per cent, the same as for the preceding year.

May 27: The Platte Valley Telephone Corp. authorized to use for its 1939 operations a depreciation rate of 5 per cent.

May 27: The Nebraska Continental Telephone Co. authorized to use for its 1939 operations a depreciation rate of 3.5 per cent.

May 29: Application filed by the Garfield Mutual Telephone Co. for authority to issue a note for $2,500. The company plans to use $1,800 to retire outstanding obligations and the remainder for working capital.

May 31: Application filed by the Lincoln Telephone & Telegraph Co. for authority to cancel grounded line rate at its Clatonia exchange as the service is now entirely metallic.

May 31: Application filed by the Milburn & Anselmo Telephone Co. for authority to extend lines, purchase the exchange and switchboard of a farmers' mutual company and to establish rates for service.

June 1: Application filed by the Hershey Telephone Co. for authority to increase rural rates from $1.25 to $1.50 a month.

June 2: Hearing held on the application of the Lincoln Telephone & Telegraph Co. for authority to close its exchange at Nora. No objections were offered, so the matter was taken under consideration.

New York Public Service Commission

June 9: Hearing in New York City on petition of the New York Telephone Co. for authority to issue $90,000,000 principal amount of refunding mortgage bonds.

Oklahoma Corporation Commission

May 3: The Southwestern Bell Telephone Co., given authority to convert its telephone exchange in Britton, from magneto to automatic equipment and, upon conversion, to charge the following rates: Britton exchange service, one-party business $3.50 monthly; one-party residence, $2.25; four-party residence, $1.75.

Britton-Oklahoma City district service, one-party business $5.50; one-party residence $4.50, to include 20 calls to Oklahoma City; excess of 20 calls, four cents each. No charge is to be made for calls by Oklahoma City subscribers to the Britton district. Toll calls between Britton and Oklahoma City, station-to-station, initial period five cents.

The order also provides that the Southwestern Bell Telephone Co. shall make effective a two-party residence rate of $2.00 per month. The 15-cent per month differential handset charge is to be eliminated when the subscriber has paid for and received such service for 18 months.

May 26: Final hearing in case brought by the commission requiring telephone companies, other than the Southwestern Bell Telephone Co., to show cause why differential charges for handsets should not be modified or abolished.

June 15: Hearing on application of the Southwestern Bell Telephone Co., for re-classification of its exchange service and adjustment of rates at Konawa.

June 16: Hearing on application of S. B. Callaham, owner of Callaham Telephone Co., Broken Bow, for investigation of switching rates and rules of service of the Oklahoma State Forestry Department.

Wisconsin Public Service Commission

June 6: Hearing in Madison on application of the Commonwealth Telephone Co. for authority to eliminate certain free toll service and special toll rates.

June 7: Hearing in Durand on application of the Nelson Telephone Co. for authority to issue $6,500 in bonds.

June 8: Hearing in Independence on application of the Independence Telephone Co. for authority to increase rates.

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MUNCIE, INDIANA

Exhibit maintained by the Missouri Telephone Co. at a cooking school conducted recently at Columbia, Mo., under the sponsorship of a local newspaper. →

The director of the cooking school placed orders for supplies over the telephone installed on the platform by the Missouri Telephone Co. The indirect telephone publicity was reflected in a station gain during the month of the school that was 300 per cent above that for the preceding month. ↓

Here and There in the Field

The Telephone Goes to Cooking School

Modern housewives appreciate more and more the value of the telephone in managing their household. At a cooking school held recently in Columbia, Mo., under the sponsorship of one of the local newspapers, the Missouri Telephone Co. was quick to take advantage of the opportunity for building up public relations and for educating more women in a greater use of their telephone. And the station gain that month was 300 per cent better than the previous month.

A telephone was installed on the platform at the cooking school. During each demonstration the director actually placed orders for supplies over the telephone from the platform, as is shown in one of the accompanying illustrations. The telephone company reports that the cooking school director put in some very good "plugs."

For the convenience of women attending the school, the telephone company installed four telephones for outgoing calls, resulting in much goodwill. The women were highly complimentary of this service.

Writing of his company's participation in the cooking school, W. N. Curtis, general superintendent of the Missouri Telephone Co., says: "It was our first attempt and we feel that we did get considerable benefit from it as our station gain that month was 300 per cent better than it was the month previously and a good many of them were extension telephones."

▼ ▼

U. S. Association Defines "Control" as Used in Its By-Laws

The board of directors of the United States Independent Telephone Association, in order to clarify its by-laws relating to membership in the association of companies in which the Bell may have a stock interest but not control, has adopted a resolution defining the word "control" to mean ownership of a majority of the voting stock.

The resolution, adopted May 15, at a meeting of the directors during the association's recent spring conference, in Chicago, reads:

"Be It Resolved, that this board of directors considers that the Supreme Court decision in the case of the Rochester Telephone Corp., which decision held the telephone company fully subject to the Federal Communi-

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Dependable and accurate.
Eliminates guess work.

A rugged portable instrument.
Every exchange should have one.

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cations Commission, does not disqualify said telephone company from membership in this association; that this board defines 'control,' as used in Article IV, Section 2 of the by-laws, to mean ownership of a majority of the voting stock."

The decision of the United States Supreme Court (TELEPHONY of April 22), referred to in the foregoing resolution, upheld an order of the FCC holding the Rochester (N. Y.) Telephone Corp. under its full jurisdiction as being subject to financial control of the Bell System. The United States association, on the other hand, has always deemed the control of a telephone company to be vested in those who actually direct its operation.

Under the interpretation of the word "control" as set forth in the resolution of the board of directors of the national Independent association, the Rochester Telephone Corp. will continue as a member of the association and the services of its president, John P. Boylan, and other members of its staff, will continue to be available to its board of directors and its executive committee.

▼ ▼

National Awards Made of Theodore N. Vail Medals

For acts of noteworthy public service performed during 1938, two silver medals, each accompanied by a cash award of $250, have been awarded by the national committee which reviews the regional awards of Theodore N. Vail bronze medals made by Bell System telephone companies.

The two silver medals were awarded after a review of the reports on 19 cases of noteworthy public service for which 22 bronze medals had already been awarded. One recipient is Jerry Frank Kincannon, employed by the Southwestern Bell Telephone Co. as an exchange repairman in Miami, Okla.

Mr. Kincannon was working at Picher, Okla., on the afternoon of May 23, 1938, when he was asked by his wire chief to go to the scene of an accident at a mine near Commerce, Okla. On arrival at the mine he found that a metal can in which three miners were being raised to the surface had dropped 60 feet to the bottom of the shaft when the hoisting apparatus collapsed. Learning that one of the miners had been killed and that the other two were seriously injured, Mr. Kincannon volunteered his services and asked that he with two miners be lowered in the mine shaft.

They made the perilous journey to the injured men over an abandoned underground route, through narrow openings, over dangerous inclines and sometimes through water several feet deep. Upon reaching the injured men Kincannon immediately went to work. Through the use of his knowledge of first aid he was able to stop the bleeding of the men, care for their broken bones and prepare them for transportation to the surface. One man later died from his injuries, but the other, through the competent and effective work of Mr. Kincannon, recovered.

The other silver medal and cash award went to George F. Wilson, installer-repairman in Grass Valley, Cal. for Pacific Telephone & Telegraph Co.

Early on the morning of February 9, 1938, Mr. Wilson and a fellow-employe started on skiis through deep snow to restore telephone service over storm-damaged lines in the rugged mountainous country near Camptonville, Cal. In the late afternoon, after being forced to abandon the job because of a severe blizzard they attempted to fight their way toward a shelter cabin a few miles away.

When they had gone almost a mile Wilson's companion collapsed in the snow. After working for about 1½ hours trying to revive his partner, Mr. Wilson covered him with his own coat and then made his way through the raging storm to the cabin, which was about a mile away, and obtained blankets and dry wood. Fighting his way back to the unconscious man, he built a fire and resumed his efforts to revive the inert man. For five hours he kept the fire going and worked hard to restore the stricken man to life. It was only after he was definitely assured that his companion was dead that Wilson left his side, and made his way to the nearest town to notify others of what had happened.

Bronze plaques in commemoration of the acts of Mr. Kincannon and Mr. Wilson were also awarded to their respective companies.

A special bronze plaque was awarded to Bell System employes, as a group, in recognition of their achievements in maintaining and restoring service that was disrupted by the hurricane which devastated the northern Atlantic states in September 1938. In making its report on the special citation the award committee said:

"In this tremendous accomplishment, it has not been possible to single out employes for individual awards. It was, rather, a system-wide cooperative effort on the part of all. The national committee believes that this self-sacrificing devotion to duty under most trying conditions, conspicuously illustrates the high ideals which govern the Bell System policy as to telephone service."

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"Telephony's" Engineering Data

By B. C. Burden

Index, Open-Wire Construction.
June 10, 1939.
No. 7-B, Page 8.

Open Wire Telephone Plant (Cont.)

In working out a simplified transposition scheme—say for a ten-wire lead whose overall length is only 15 miles—there would be no particular need for transposing circuit 1-2 with respect to circuit 7-8, or 9-10 as the table shows that we could go more than 40 miles untransposed and yet these particular circuits would not interfere with each other materially. We would need, however, to transpose adjacent circuits against

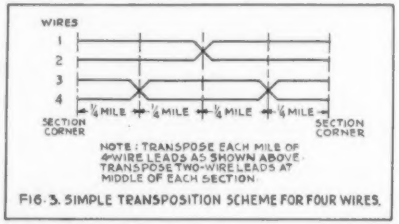

FIG. 3. SIMPLE TRANSPOSITION SCHEME FOR FOUR WIRES.

each other; also alternate circuits as, for example, circuit 1-2 and 3-4 and circuit 1-2 against circuit 5-6. Several schemes suitable for use for short non-phantomed toll lines or for rural lines are shown in Figs. 3 and 4.

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The application of phantom circuits to an open-wire lead saves wire but increases the cost of transpositions. Phantom circuits must be transposed not only with respect to other circuits on the same lead and power lines

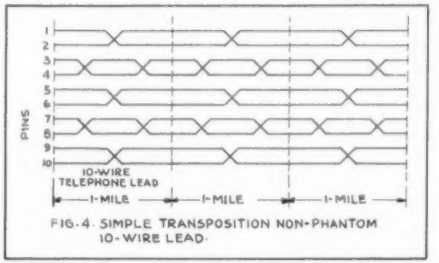

FIG. 4. SIMPLE TRANSPOSITION NON-PHANTOM 10-WIRE LEAD.

but also with respect to the side circuits of which the phantom is composed.

Phantom Transposition Schemes

The transposition of a phantom circuit requires that the two side circuits of which the phantom is composed, be interchanged as to pin positions and at the same time the side circuit itself may require transposition. There are four types of phantom transpositions known as: One, two, three and four. The four types are illustrated in Fig. 5.

All four types transpose the phantom to other circuits on the same lead or to power lines. However, the effect on side-circuit to side-circuit, or side-circuit to phantom circuit balance is different for the several types. The four types are needed in the fully-balanced transposition schemes used on major toll lines, but for ordinary work only two of the types need be used. A simplified transposition scheme, suitable for phantomed lines, is shown in Fig. 6.

Use of Phantom Circuits

A phantom circuit is an arrangement whereby three talking circuits can be obtained from four wires. This is accomplished by the use of repeating coils connected as shown in Fig. 7. In designing open-wire plant phantom circuits may be used and thereby a saving in wire effected. The economy in wire costs may be largely

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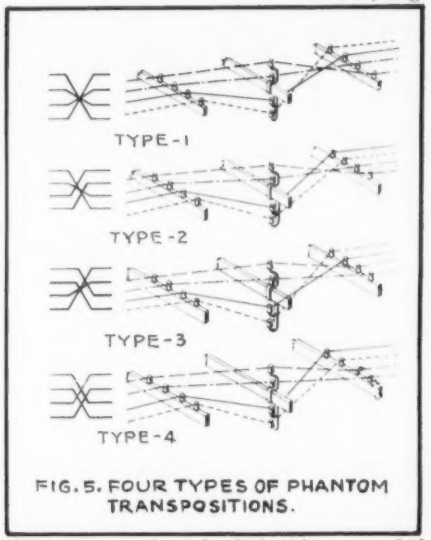

FIG. 5. FOUR TYPES OF PHANTOM TRANSPOSITIONS.

offset, however, on short leads by the cost of the repeating coils and protective equipment that is required.

Phantom circuits have several other disadvantages which should be taken into account when considering their use. These are:

(1) The repeating coils used in the phantom circuits increase the transmission loss on the circuits by about 0.5 db per coil.

(2) Repeating coils introduce a small ringing loss.

(3) Repeating coils make it difficult to test the line with a wire chief's voltmeter from the central office.

The transmission and ringing losses are not serious where phantoms are applied to rural lines which are not too heavily-loaded with stations, and where the lines are well maintained from a transmission standpoint. The testing objection can be partially met by arranging the repeating coils at the office end on test jacks in such manner that the coils can be cut out of circuit when measurements are to be made from the office toward the line.

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IN THE NATION'S CAPITAL

(Continued from page 15)

of productive commerce and into the blood-sucking category of government tax-exempts, should be a matter for shame rather than boasting.

Again, the comparison of per capita indebtedness in the United States with the citizen of Great Britain is true enough so far as it goes; but it overlooks the fact that the British government is much nearer to living within its income than the American government, which is now hopelessly committed to deficit financing (eating tomorrow's dinner today), without even an excuse of a plan for ultimate correction.

Such international debt comparisons also overlook the much more important *rate of increase*. England's debt, with all its heavy rearmament program, has increased about 7 per cent during the last ten years. Our national debt has increased nearly 150 per cent during the same period.

Finally, it is easy to scoff at Senators who wistfully pine for more sane financial policies but who are driven by political expedience to vote for higher appropriations in order to keep their jobs in the Senate (the same would go for the lower house). This in itself is a sad commentary upon the present state of educated democracy. There may come a time (as happened in the case of the prohibition issue) when it will be politically safe to vote for economy in Congress as well as talk about it.

We can only hope that this situation will soon improve, and that the American voters will realize that the federal government has no secret source of revenue. Meantime, it is certainly better to have men in the Senate who will put up a good argument once in a while for economy—even if they have to vote against it occasionally—than those who have such utter disregard for the credit of the country that they not only vote increasing deficits without thought but sneer at those who question the wisdom of such a course.

Nor should private business lose sight of the ultimate effect of government financing upon the ability of private business to get money to keep going. The following state-

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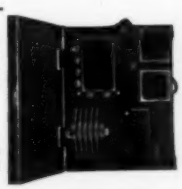

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ment covering French experience during the last decade and written by the present Finance Minister of France, Monsieur Paul Reynaud, should command respectful attention:

"For four years the State absorbed the whole of our national savings, mainly for unproductive purposes. Despite all the artificial measures taken to reduce interest rates, to grant advances to traders and industrialists, the French loan market has become one of the dearest in the world.

Everyone knows that in practice it is impossible to obtain mortgage loans at under 9 or 10 per cent. Everyone knows that if there is the slightest risk, a private borrower cannot obtain capital at less than 10 or 12 per cent.

Between 1928 and 1937 private issues of shares fell from 8.3 billions of francs to 1.2, while private issues of bonds fell from 6.4 to 2.3 billions. The drop is large enough, but would be even greater if account were taken of the depreciation of the franc. The collapse of private borrowing is due to the scarcity of available capital, a scarcity due principally to constant appeals from what has become almost the one and only borrower, the State."

COMING CONVENTIONS

Wisconsin Independent Telephone Association, Loraine Hotel, Madison, June 13.

Wisconsin State Telephone Association and Wisconsin Locally Owned Telephone Group, Park Hotel, Madison, June 13-15.

Joint convention: New Hampshire Telephone Association and Vermont Telephone Association, Woodstock Inn, Woodstock, Vt., June 20, 21 and 22.

Washington Independent Telephone Association, Hotel Monte Cristo, Everett, June 23 and 24.

Oregon Independent Telephone Association, Portland Hotel, Portland, June 26.

California Independent Telephone Association, Miramar Hotel, Santa Monica, June 29 and 30.

Michigan Independent Telephone Association, Hotel Olds, Lansing, July 26 and 27.